R E P O R T R E S U M E S

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AUDITORY-VISUAL PERCEPTUAL SHIFTING IN SPEECH HANDICAPPED CHILDREN.

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INTERACTION BETWEEN VISION AND HEARING WERE STUDIED IN 35 SPEECH HANDICAPPED FIRST-GRADE CHILDREN. THE ABILITY TO SHIFT ATTENTION FROM ONE SENSORY MODALITY TO ANOTHER WAS LABELED AS "PERCEPTUAL SHIFTING." A DEVICE DEVELOPED BY EXPERIMENTAL PSYCHOLOGISTS PRESENTED VARIOUS STIMULI TO EACH SUBJECT AND RECORDED THE SUBJECT'S REACTION TIME. STIMULI CONSISTED OF (1) A RED LIGHT, (2) A BUZZER, OR (3) BOTH LIGHT AND BUZZER. STUDENTS TOUCHED A PANEL TO REACT AND TERMINATE THE STIMULUS. STIMULI WERE PRESENTED IN RANDOM ORDER SO THAT NINE DIFFERENT STIMULUS-SHIFT CONDITIONS WERE TESTED. THE CONTROL GROUP OF 70 NORMAL SPEAKING FIRST-GRADE CHILDREN WAS SELECTED FROM PUBLIC SCHOOLS. RESULTS OBTAINED DEMONSTRATED THAT THE SPEECH DEFECTIVE CHILDREN STUDIED WERE MORE HANDICAPPED ON TASKS OF AUDITORY-VISUAL PERCEPTUAL SHIFTING WHEN COMPARED WITH THEIR NORMAL SPEAKING PEERS. WITHOUT ADDITIONAL RESEARCH, IT WAS CONSIDERED PREMATURE TO USE PERCEPTUAL SHIFT IN THE DIAGNOSIS OF SPEECH DEFECTS. (JM)

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Auditory-Visual Perceptual Shifting in Speech Handicapped Children

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Cooperative Research Project No. S-095

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1964

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I. Statement of Problem

Investigations into various aspects of sensory mechanisms have yielded a limited amount of information with respect to causative factors in Speech Pathology. Knowledge regarding peripheral vision and audition has been useful, however, there is little empirical data regarding central mechanisms of hearing and tactile-kinaesthetic sensitivity. Relationships between various sensory modalities are less clear to workers in the field.

Working on the assumption that individual sensory modalities operate as separate entities and often in coordination with one another during speech-language development - there is a continuous monitoring between modalities - is it also reasonable to assume it is possible that arrest in speech development may suggest a breakdown in these sensory relationships and/or lack of coordination between various sensory avenues? The paucity of research information relative to the interaction between sensory modalities and its effect on normal speech-language learning, poses a major problem to speech and hearing pathologists.

The overall problem of sensory coordination poses interesting questions for researchers who are interested in speech-language disability and particularly for those who are interested in disorders of severe functional articulation classification and/or delayed speech. Major questions are: (1) are all sensory avenues utilized during the perceptual process; (2) are certain modalities more dominant during the process; (3) does extinction of sensory stimuli occur during perception of two different stimuli presented

simultaneously; and (4) is perceptual shifting important in the total process? Because the overall problem is so great in magnitude, only the latter aspect "perceptual shifting"[1], will be investigated in this study.

Perceptual shifting may play a most significant role in the process of learning, be it speech, reading, mathematics or any area of learning involved in the process of education. Its significance to education may be grasped only after consideration of how much perceptual shifting is involved during any process of learning. In school, the teacher is continuously presenting visual and auditory stimuli, while the student is constantly employing both of these modalities simultaneously, or he is shifting from one modality to another in an attempt to comprehend what is being set before him. During this complicated process, he may be called upon to enlist other sensory processes, eg: tactile-kinaesthetic (writing, reciting, etc.), thus adding to the critical necessity of perfect coordination between sensory modalities. This coordination, or interaction, between sensory avenues is vital to proper perceptual processing of information being transmitted to the sensory cortex via the afferent pathways.

In the field of speech and hearing therapy, the problem of perceptual shifting may be most critical. Success in rehabilitation is often dependent upon using a "multi-sensory" approach,

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[1]Perceptual shifting may be defined as the ability to shift attention from one sensory modality to another (eg: auditory to visual, etc.).

during which every possible sensory pathway is utilized. Inadequate perceptual shifting ability could be a major interfering factor in the rehabilitation process. It is also possible that a refined method of evaluating perceptual shifting abilities could open new research avenues in most areas of Special Education of handicapped children, and particularly with mentally handicapped populations.

The significance of perceptual shifting to education and especially to the field of speech and hearing therapy, appears to be vital. The purpose of this study, therefore, is to provide information (data) relative to the perceptual shifting abilities of speech-handicapped and normal speaking children. Specifically, reaction time performances on tasks involving attentional shifts between auditory, visual and combined auditory-visual modalities will be measured.

II. Objectives and Hypotheses

The research reported herein was designed to achieve the following goals:

(1) to evaluate the auditory-visual perceptual shifting abilities of early elementary school aged speech handicapped children (severe functional articulation and/or speech-language delay classifications) and their normal speaking peers;

(2) to compare the reaction times of speech handicapped and normal speaking children to auditory and visual stimuli during shifting from one modality to various other modalities; and

(3) to offer rationale which will either suggest or preclude further large scale research in the area under investigation, but with meaningful auditory and visual symbols.

In view of the stated objectives, the "null" hypothesis can be stated as follows: there are no significant differences in the reaction times (responses to stimuli), during perceptual shifting from auditory to visual stimulus, to auditory stimulus, etc. of speech defective and normal speaking children. The working hypothesis may be stated, eg: do normal speaking children perform significantly better on tasks involving auditory-visual perceptual shifting skills than do children identified as manifesting specific speech difficulties?

III. Related Research

Information concerning interaction between audition and vision as related to speech and hearing problems (with the exception of the area of speech reading) is virtually nonexistent. In the area of speech delay (often referred to as severe functional articulation disorder) no known experimentation has been conducted with respect to perceptual shifting abilities of any kind. Other disciplines - primarily Experimental Psychology - have initiated some work in an attempt to evaluate reaction times on tasks which require a shift of attention from one modality to another.

Raab, Deutsch and Freedman (1960) were among the first to initiate investigations in perceptual shifting with children. Their work in evaluating this ability in normal school children of

different reading achievement levels, was based on the "Preparatory Set" concept advanced by Mowrer, Rayman and Bliss (1940). The investigators found that differences in reaction time performance exist between good and retarded readers. More specifically, they discovered significant differences in visual responsivity and efficiency. and in "set formation" in both visual and auditory modalities. Sutton, Hakerem, Portnoy and Zubin (1961) utilized the sensory modality shifting approach in comparing schizophrenic and normal subjects on this ability. The results indicated that schizophrenics manifested greater lengthening of reaction times to a second stimulus in a crossmodal situation (eg: visual stimulus followed by auditory stimulus). The investigators seemed to suggest that the normals were superior in neurophysiological "selective action", with respect to numerous sensory inputs. Benton, Sutton, Kennedy and Brokaw (1962) studied crossmodal reaction times of subjects with cerebral pathology. The authors found similar significant "lengthening" of reaction time in their neurological patients. Katz and Deutsch (1963) investigated reaction times to sequentially presented visual and auditory stimuli of 48 Negro boys, selected from grades one, three and five. The results indicated that: (a) age level in the perceptual shifting task was significant....older children exhibited faster over-all reaction times; and (b) retarded readers manifested greater difficulty than normal readers in shifting from one modality to another. The researchers concluded their results supported the hypothesis that poor readers cannot shift attention between modalities as rapidly as normal readers.

IV. Procedure

A. Subjects

1. Subjects were 70 first grade public school children. The experimental group was composed of 35 speech-language delayed, second semester, first grade children who were referred for speech examination by qualified Speech Therapists working in the Northeastern New York - Capital District public school districts area. The Templin-Darley Test of Articulation was administered to the children referred, to assist in the determination of severity classification. The opinions of the investigator and the referring therapists were also taken into consideration in the selection process. Thirty-five children were identified as manifesting severe speech-articulation difficulty. Subjects were selected in accordance with the following additional criteria: (a) were within I.Q. range of 90-120; (b) were within chronological age range of 6.5 - 7.5; (c) passed a pure tone audiometric test indicating normal peripheral hearing for both ears at +10 decibels or better (testing frequencies 250, 500, 1000, 2000, 4000 c.p.s.); (d) were free of any observable gross organic and/or structural abnormalities (eg: cerebral palsy; cleft palate, etc.); (e) did not have a history of emotional involvements of any kind (eg: schizophrenia, etc.); (f) were free of peripheral vision problems (aided); and (g) all subjects were selected from as near the same socio-economic class as possible.

2. The control group was selected at random from a population

of normal speaking first grade public school children. Although the sampling technique should be considered as being of the "clustered" random classification, precautions were taken to approximate as closely as possible, the same socio-economic class as the subjects assigned to the experimental group. With the exception of the Templin-Darley test, the criteria for selection were the same as those enumerated for the experimental group.

In addition to the tests mentioned above, the Peabody Picture Vocabulary Test was administered to both groups to estimate each subject's receptive vocabulary level via his hearing mechanism and to arrive at Mean I.Q. scores for the experimental and control groups.

B. Apparatus

The apparatus employed in this research could be described as a bi-modal reaction time device. The unit was used to present either a buzzer or red light, or both buzzer and light (simultaneous presentation) to a subject, thus allowing the subject to react and terminate the stimulus electronically.

The reaction time was recorded on a chronoscope (C.H. Stoelting Company, Model 20225A). The reaction circuit was calibrated to at least 1/100 of a second.

The unit was operated by 110 volt 60 cycle A.C. A 10 volt transformer was used to produce a step down voltage to both the light and the buzzer. The light required only 6 to 8 volts to produce white light or physical light, thus the 10 volts increased the reaction time between black or cold light to the white light or

physical light to 1/100 of one second.

The experimenter selected either buzzer, lamp, or both as the stimulus according to the stimulus program designed for the presentation (see Appendix A). Micro switches were included in the circuit to produce a time constant of at least 1/100 of a second. The experimenter and subject did not have to fumble with a cumbersome switch. The switch had to be touched lightly to either produce a stimulus or stop the stimulus reaction.

The unit was housed in steel cases, and all wires and switches were isolated from these cases for the prevention of shock. (See diagram, Appendix B).

The stimulus program was prepared to have each stimulus condition (buzzer, light, and both) presented to the subject in random order, even though care was taken that each individual stimulus was preceded by every other stimulus an equal number of times. This circumstance allowed for nine different stimulus conditions to occur. The stimulus conditions were: (1) visual to auditory; (2) visual to visual; (3) visual to both (combined auditory and visual); (4) auditory to auditory; (5) auditory to visual; (6) auditory to both; (7) both to auditory; (8) both to visual; and (9) both to both. The interval time between stimuli presentation varied randomly, lasting between 3.0 - 6.0 seconds. The stimulus program allowed for a one minute rest period at the end of each block of eighteen stimuli presentations. Each stimulus condition was presented six times, thus allowing for 54 stimuli to be presented in three blocks of eighteen stimuli each.

For the presentation of the experimental stimuli, each subject was seated at a table approximately two feet from the stimulus box. The box was at face level, with no extraneous visual stimuli in the background. The subject was instructed to look and listen for a red light or buzzer, or both red light and buzzer, and to press down on the microswitch as soon as he saw or heard one of the stimuli described. Each of the stimuli were presented once or twice to acquaint the subject with the reaction desired. The subjects were encouraged to depress the switch as soon as possible following the onset of the stimulus.

V. Analyses of the Data and Findings

To adequately test the hypothesis initially proposed, the following statistical analyses were performed: (1) an analysis of variance (Treatment x Levels, Lindquist 1953); and (2) a test of critical difference between individual pairs of means (Lindquist 1953). The results of the analysis of variance of auditory-visual perceptual shifting for the experimental and control groups are presented in Table 1.

Table 1.

Summary of analysis of variance of perceptual shifting for the speech defective and normal speaking groups.

Source	df	ss	ms	F	p
Between Groups (G)	1	154003.97	154003.97	63.04	.01
Between Tasks (T)	8	617020.38	77127.55	31.57	.01
G x T	8	25190.35	2148.79	1.29	NS
Error	612	1495124.06	2443.01		
Total	629	2291338.76			

As can be seen in Table 1., the F ratio obtained between the speech defective and normal speaking groups was significant at the .01 level of confidence. Both groups taken together, differences among tasks were significant at the .01 level of confidence, however, some tasks differentiated better than others. These differences did not show enough diversity to result in a significant interaction effect. A critical difference test was employed to determine any two sets of means which were significant at or below the .01 level of confidence. The differences are demonstrated in Appendix C. (differences greater than 30 msec. are statistically significant at the .01 level of confidence).

Appendix C. shows that the differences of six out of nine perceptual shifting tasks were significant at the .01 level of confidence. The greatest differences were found in all three categories involving attentional shifting from either auditory, visual, or combined auditory-visual ("both") modalities to the visual modality. The visual to visual and both to visual categories demonstrated the greatest differences between experimental and control groups of all categories utilized in the study. For "pure" contramodal shifting, both categories (auditory to visual and visual to auditory) had differences which were significant statistically. Both combined categories (both to visual and both to auditory) also demonstrated significant differences. The combined shifting categories (eg: both to auditory and both to visual) should be considered as being contramodal perceptual shifting situations to some degree. All ipsimodal categories - save the visual to visual -

yielded non-significant differences (including both to both).

Table 2. represents the means and standard deviations for the experimental and control groups for I.Q., receptive vocabulary, Templin-Darley, and CA.

Table 2.

Means and standard deviations for speech defective and normal speaking groups on measures of I.Q., receptive vocabulary, CA, and T-D. (N=35, for each group)

Test	Speech defective group Means	SD	normal speaking group Means	SD
I.Q. (Peabody)	106.43	11.72	106.40	12.40
Receptive Vocabulary (Peabody)	64.06	6.03	64.06	6.35
CA	6.72	4.41	6.79	3.90
T-D (50 item; No. Corr.)	24.83	8.14		

VI. Conclusions and Implications

The results obtained in this study clearly indicate that the speech defective children utilized in this study were considerably more handicapped on tasks of auditory-visual perceptual shifting when compared with their normal speaking peers. The F ratios demonstrated that the normal speaking children were found to be superior to the speech defective children in the between groups and the between tasks analyses.

In discussing the results of the present study, one must do so in light of previous findings in related areas. As was anticipated, the contramodal (crossmodal, or shifting from a particular modality to a different modality) shifting conditions differentiated the experimental from the control groups much more discreetly

than did the ipsimodal conditions (shifting within a modality, eg: auditory to auditory), with the exception of the visual to visual category. These results appear to lend support to similar findings of previous investigators (Sutton, et.al. 1961; Benton, et.al. 1962; Katz and Deutsch 1963) who found that their experimental groups had significantly more difficulty in shifting attention in contramodal rather than ipsimodal conditions. The only disparate results were found in the visual to visual category which is a "pure" ipsimodal shifting situation. Non-significant differences were found in the two other ipsimodal conditions (auditory to auditory and both to both).

At this point, the writer feels compelled to venture into a consideration of Davis' (1962) discussion of auditory and visual interaction in the CNS. Davis mentions that "some neurons from the inferior colliculus pass to the near-by superior colliculus which is an important nucleus of the optic system." Davis goes on to speculate that coordination of auditory and visual activity may take place in that portion of the CNS. He then explores the possibility that coordination of auditory and other sensory impulses may also take place in the area of the projection of the auditory system to the vermis of the cerebellum. Davis indicated that the vermis of the cat responds to auditory, visual or tactile stimuli and also when electrical stimulation is applied to the auditory or visual "cortices". In light of the findings of the present study, relative to auditory-visual interaction, it would be interesting to speculate as to the central involvement of the auditory-visual

perceptual shifting concept and its possible implications in diagnosis and in consideration of etiological factors involved in speech delay.

With respect to the "both" category (combined auditory-visual simultaneous presentation), the investigator originally postulated that speech delayed children would have considerably more difficulty in accommodating two simultaneous stimuli of different modalities, especially in view of the fact that many of the children in this group were suspected of being dysphasic, or to some degree, manifested some form of concomitant language disturbance. The contention here being that interference in perceiving two simultaneously presented stimuli could take place in the form of sensory modality extinction and/or masking (Critchley, 1949). To add support to this contention, Katz and Deutsch (1963) discovered that poor readers had considerable difficulty in responding to two stimulus modalities correctly at the same time. They further observed that in vigilance performance - tasks where auditory and visual stimuli were presented in combined form - some of the younger poorer readers ignored one modality completely, while they responded appropriately in the other.

Another interesting result is concerned with shifting categories which demonstrated the greatest differences between the experimental and control groups. In each case, shifting from a given sensory modality to the visual modality produced severe difficulty in both groups, with a significant difference being recorded in favor of the normal speakers. The visual to visual category

demonstrated a difference of almost twice the amount (beyond the 30 msec. level) required for statistical significance at the .01 level of confidence. The both to visual category displayed the next greatest difference between groups. These results are of especial interest since the visual to visual shifting category is an ipsimodal shifting situation. No logical explanation can be offered for this confounding finding unless one considers the fact that all conditions involving a shift from a given modality to the visual modality involve great significant differences between the speech defective and normal speaking groups.

With regard to the diagnostic possibilities of the perceptual shifting concept, it is the feeling of the present investigator that it would be premature to presume that a deficiency in auditory-visual perceptual shifting ability could be of primary etiological significance in speech delay at this time. Some consideration should be given to individual factors uncovered in this study, however, much more work needs to be conducted in this area with speech defective children of various classifications - and especially with children of known CNS impairment and with the mentally retarded - before any definite conclusions could be arrived at relative to the diagnostic efficiency of this technique. Furthermore, the author feels strongly that further research should be conducted while utilizing meaningful auditory, visual, and combined auditory-visual symbols with the populations mentioned.

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A. Auditory-Visual Perceptual Shifting Reaction Time Data Table

Subjects Name:_____ Age:_____ Teachers Name:_____

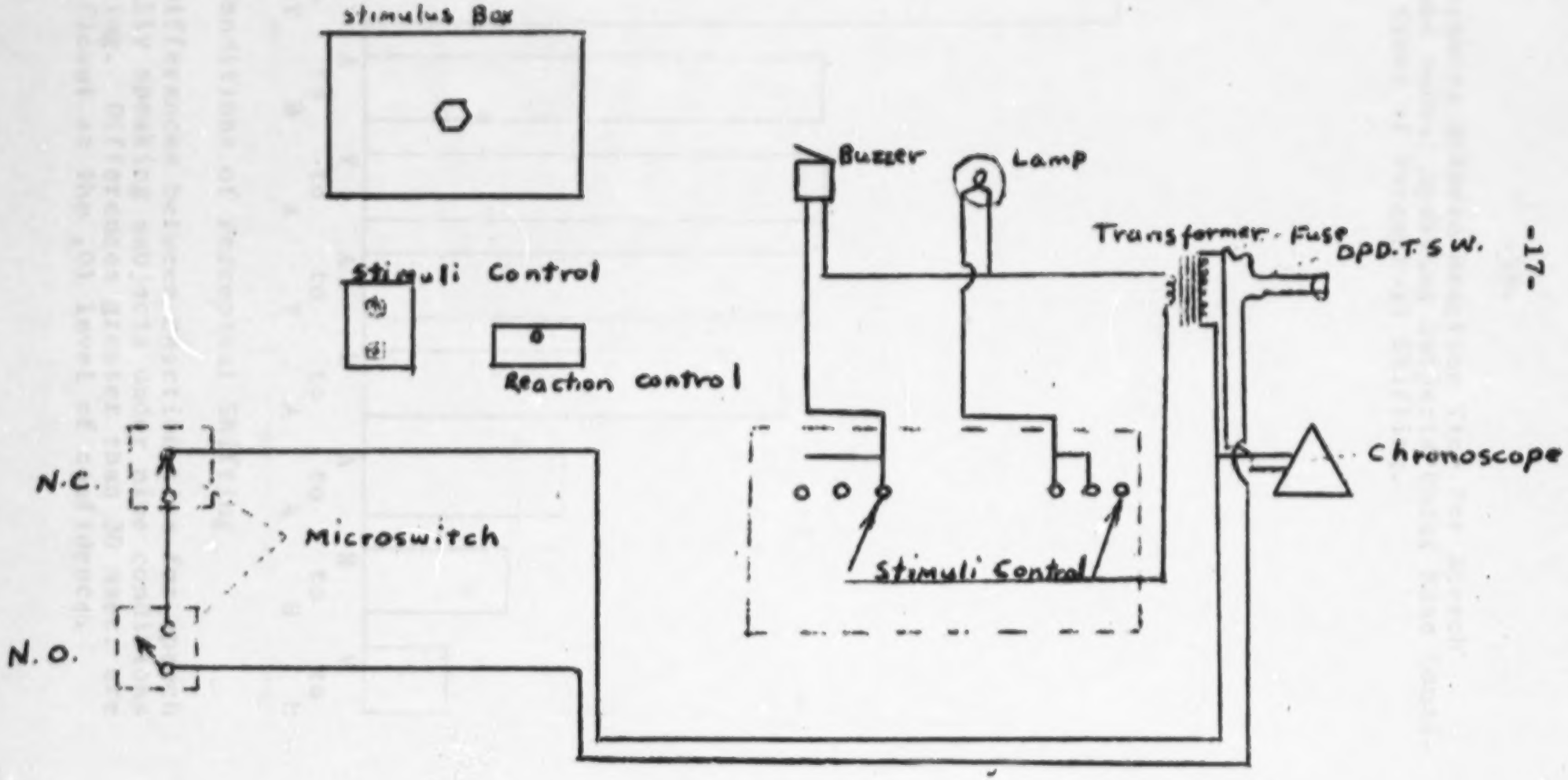
School:_____ School Address:_____

BLOCK I	SCORING CATEGORY	BLOCK II	SCORING CATEGORY	BLOCK III	SCORING CATEGORY
L	(0)	BUZ	(0)	SAV	(0)
L	(2)	SAV	(6)	SAV	(9)
BUZ	(1)	SAV	(9)	BUZ	(7)
SAV	(6)	BUZ	(7)	BUZ	(4)
SAV	(9)	BUZ	(4)	L	(5)
BUZ	(7)	L	(5)	SAV	(3)
BUZ	(4)	SAV	(3)	L	(8)
L	(5)	L	(8)	L	(2)
SAV	(3)	L	(2)	BUZ	(1)
L	(8)	BUZ	(1)	SAV	(6)
L	(2)	SAV	(6)	SAV	(9)
BUZ	(1)	SAV	(9)	BUZ	(7)
SAV	(6)	BUZ	(7)	BUZ	(4)
SAV	(9)	BUZ	(4)	L	(5)
BUZ	(7)	L	(5)	SAV	(3)
BUZ	(4)	SAV	(3)	L	(8)
L	(5)	L	(8)	L	(2)
SAV	(3)	L	(2)	BUZ	(1)
L	(8)	BUZ	(1)	SAV	(6)

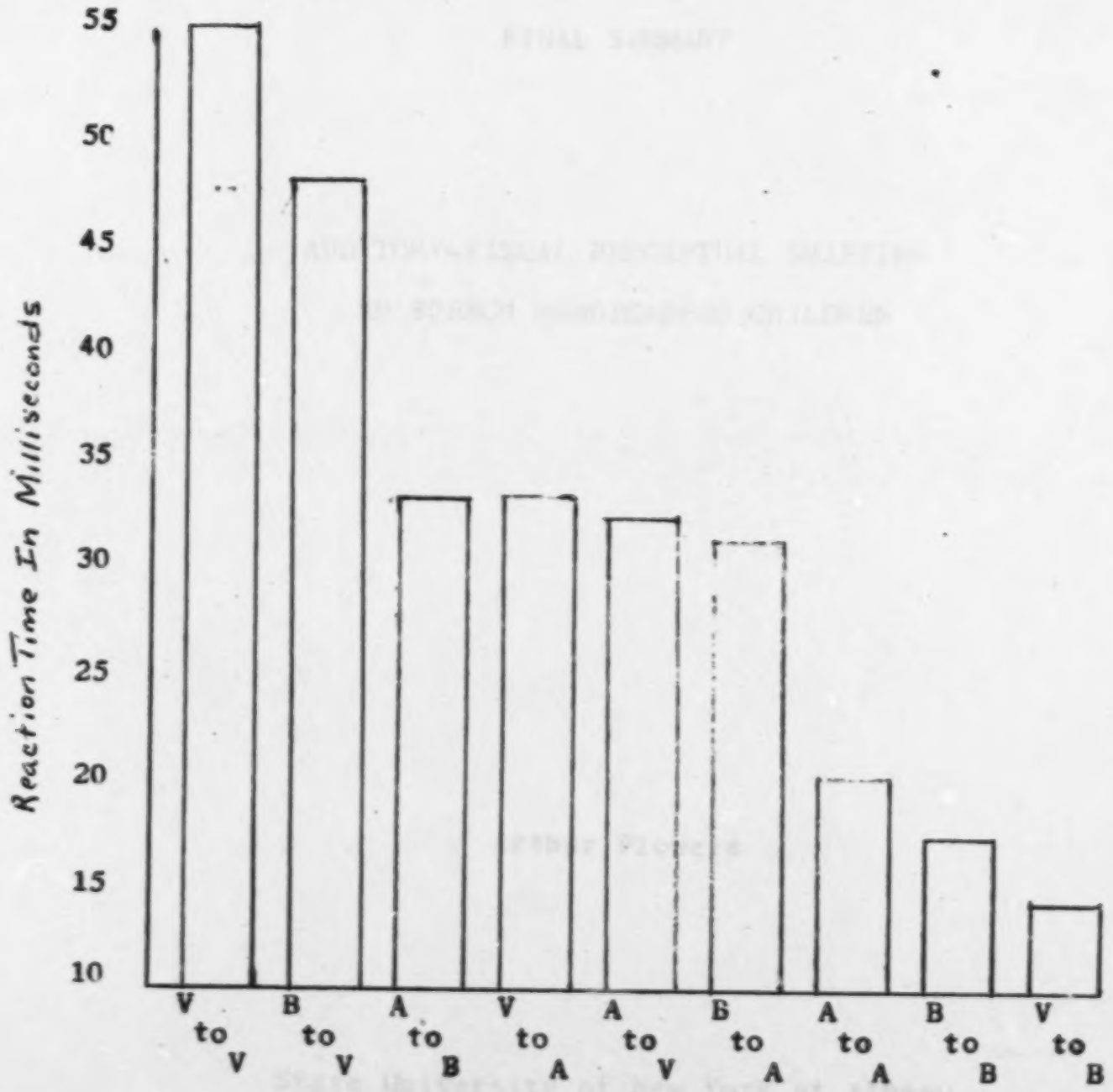
Scoring Categories & Total Reaction Times for Shifting Categories:

1. Visual to Auditory_____
2. Visual to Visual_____
3. Visual to SAV:_____
4. Auditory to Auditory:_____
5. Auditory to Visual:_____
6. Auditory to SAV:_____
7. SAV to Auditory:_____
8. SAV to Visual:_____
9. SAV to SAV:_____
0. Starting Stimulus:_____

B. Circuit Diagram for the Reaction Time Apparatus
(From a design suggested by Drs. S. Sutton and G. Hakerem, modified by J. Angus)



C. Differences Between Reaction Time For Speech Defective and Normal Speaking Subjects Under Nine Conditions of Perceptual Shifting.



Appendix C. Differences between reaction time for speech defective and normally speaking subjects under nine conditions of perceptual shifting. Differences greater than 30 msec. are statistically significant at the .01 level of confidence.

FINAL SUMMARY

AUDITORY-VISUAL PERCEPTUAL SHIFTING IN SPEECH HANDICAPPED CHILDREN

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Cooperative Research Project No. S-095
Duration: April 1964 to November 1964.

BACKGROUND

It is well accepted by research workers that the auditory and visual modalities are most relied upon by children in the initial stages of speech development. Prevailing theories that defects of audition might be primary etiological factors in speech delay are widely accepted by authorities in the field. Auditory and visual perceptual abilities have been investigated individually and apart from one another, but little work has been attempted to determine the relationship of vision to audition, especially with respect to delayed speech development.

A limited amount of work with regard to auditory-visual interaction has been completed relative to reading achievement and in some areas of emotional illness. To date, very little research of this kind has been attempted in the field of Speech Pathology and Audiology. Instrumentation developed by experimental psychologists has provided new methodology for the evaluation of sensory interaction, labeled as "perceptual shifting". This procedure allows the investigator to present basic auditory and visual stimuli in sequential order so that reaction times may be obtained to the subject's responses. The current study modifies the basic approach of "perceptual shifting" in that attentional shifting in speech handicapped children is measured to combined auditory-visual stimuli in addition to various ipsimodal and contramodal auditory-visual shifting situations.

OBJECTIVES

The research reported herein was designed to achieve the following goals:

(1) to evaluate the auditory-visual perceptual shifting abilities of early elementary school aged speech handicapped children (severe functional articulation and/or speech-language delay classifications) and their normal speaking peers;

(2) to compare the reaction times of the experimental and control groups to auditory and visual stimuli during shifting from one modality to various other modalities. Stimulus shifting categories were: 1) visual to auditory; 2) visual to visual; 3) visual to both (combined auditory and visual); 4) auditory to auditory; 5) auditory to visual; 6) auditory to both; 7) both to auditory; 8) both to visual; and 9) both to both; and

(3) to offer rationale which will either suggest or preclude further large scale research in the area under investigation.

PROCEDURE

1. Subjects:

Subjects were 70 first grade public school children. The experimental group was composed of 35 speech handicapped, second semester, first grade children, who were referred for speech examination by qualified speech therapists working in the Northeastern New York - Capital District public school districts area. The Templin-Darley Test of Articulation was administered to the children referred, to assist in the determination of severity

classification. The opinions of the investigator and the referring therapists were also taken into consideration in the selection process. Thirty-five children were identified as manifesting severe speech-articulation difficulty. Subjects were selected in accordance with the following additional criteria: (1) were within I.Q. range of 90-120; (2) were within chronological age range of 6.5 - 7.5; (3) passed a pure tone audiometric test indicating normal peripheral hearing for both ears at +10 decibels or better (testing frequencies 250, 500, 1000, 2000, 4000 c.p.s.); (4) were free of any observable gross organic and/or structural abnormalities (eg: cerebral palsy; cleft palate; etc.); (5) did not have a history of emotional involvements of any kind (eg: schizophrenia, etc.); (6) were free of peripheral vision problems (aided); and (7) all subjects were selected from as near the same socio-economic class as possible.

The control group was selected at random from a population of normal speaking first grade public school children. With the exception of the Templin-Darley test, the criteria for selection were the same as those enumerated for the experimental group.

In addition to the tests mentioned above, the Peabody Picture Vocabulary Test was administered to both groups to estimate each subject's receptive vocabulary level via his hearing mechanism and to arrive at Mean I.Q. scores for the experimental and control groups.

2. Technique and Instrumentation:

The apparatus employed in this research could be described as

a bi-modal reaction time device. The unit was used to present either a buzzer or red light, or both buzzer and light (simultaneous presentation) to a subject, thus allowing the subject to react and terminate the stimulus electronically.

The reaction time was recorded on a chronoscope. The reaction circuit was calibrated to at least 1/100 of a second.

The experimenter selected either buzzer, lamp, or both as the stimulus, according to the stimulus program designed for the presentation.

The stimulus program was prepared to have each stimulus condition (buzzer, light, and both) presented to the subject in random order, even though care was taken that each individual stimulus was preceded by every other stimulus an equal number of times. This circumstance allowed for nine different stimulus conditions to occur. Stimulus conditions were: (1) visual to auditory; (2) visual to visual; (3) visual to both (combined auditory and visual); (4) auditory to auditory; (5) auditory to visual; (6) auditory to both; (7) both to auditory; (8) both to visual; and (9) both to both. The interval time between stimuli presentation varied randomly, lasting between 3.0 - 6.0 seconds. The stimulus program allowed for a one minute rest period at the end of each block of eighteen stimuli presentations. Each stimulus condition was presented six times, thus allowing for 54 stimuli to be presented in three blocks of eighteen stimuli each.

For the presentation of the experimental stimuli, each subject was seated at a table approximately two feet from the stimulus box.

The box was at face level, with no extraneous visual stimuli in the background. The subject was instructed to look and listen for a red light or a buzzer, or both a red light and a buzzer, and to press down on the microswitch as soon as he saw or heard one of the stimuli described. Each of the stimuli were presented once or twice to acquaint the subject with the reaction desired. The subjects were encouraged to depress the switch as soon as possible following the onset of the stimulus.

3. Statistical Analysis

A "Treatment x Levels" analysis of variance (Lindquist 1953) was performed to test the original hypothesis of the study. A critical difference test (Lindquist 1953) was employed to determine whether the difference between any two sets of means was significant at or below the .01 level of confidence.

RESULTS

(1) The F ratio for the between groups variance was 63.04, $p < .01$).

(2) The F ratio for the between tasks variance (both groups taken together) was 31.57, $p < .01$).

(3) The interaction effect (groups x tasks) was not significant at the .05 level.

(4) A critical difference test indicated that six out of nine perceptual shifting tasks demonstrated differences between the speech defective and normal speaking children which were statistically significant at the .01 level of confidence. The differences

were in favor of the normal speaking group.

(5) Greatest differences between groups were found in all categories involving shifting to the visual modality from the auditory, visual, and auditory-visual combined modalities.

(6) The visual to visual shifting category offered the greatest difference between the experimental and control groups.

(7) Most contramodal shifting situations yielded significant differences between groups.

(8) The ipsimodal shifting situations generally demonstrated non-significant differences between groups (except the visual to visual category).

(9) All combined (simultaneously presented auditory and visual stimuli) categories yielded significant differences between groups.

CONCLUSIONS AND IMPLICATIONS

(1) The results indicate that the speech defective children were significantly slower in reacting to tasks involving auditory-visual perceptual shifting when compared with their normal speaking peers.

(2) Contramodal shifting conditions showed much greater differences between the experimental and control groups than did the ipsimodal conditions (with the exception of the visual to visual category) which were non-significant in this respect. These findings support previous research evidence.

(3) All combined shifting categories - save both to both, a

form of ipsilateral shifting - demonstrated significant differences between groups, suggesting that sensory modality extinction and/or masking may be interfering in the perception of two simultaneously presented stimuli of different modalities.

(4) The great significant differences between groups found in categories requiring shifting to the visual modality from a given modality (eg: auditory to visual, visual to visual, etc.) suggest that abilities to shift to the visual modality may be critical in speech delayed children. The greatest difference obtained in the visual to visual shifting category cannot be explained at this time relative to the speech defective sample.

(5) It is much too early to assume that the perceptual shifting technique may be of diagnostic assistance in cases of speech delay.

(6) It is suggested that further investigation be conducted with variously classified speech defective children, mentally retarded populations and with children with known CNS impairment. This experimentation should utilize meaningful language symbols as the visual, auditory, and combined visual-auditory experimental stimuli.

BIBLIOGRAPHY

There are 11 references listed in the final report.